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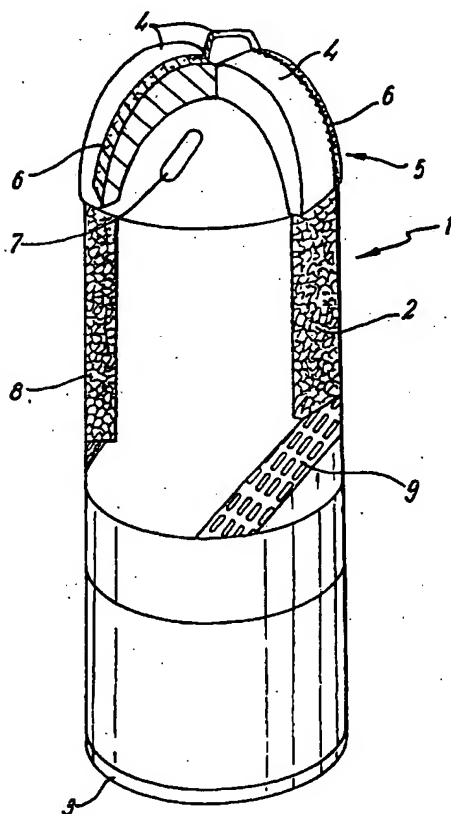
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[Continued on next page]

(54) Title: DRILLING BIT FOR DRILLING WHILE RUNNING CASING



(57) Abstract: A drill bit for drilling casing in a well bore. The drill bit is constructed from a combination of relatively soft and relatively hard materials. The proportions of the materials are selected such that the drill bit provides suitable cutting and boring of the well bore while being able to be drilled through by a subsequent drill bit. Methods of applying hard materials to a soft material body are provided.

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DRILLING BIT FOR DRILLING WHILE RUNNING CASING

1

2

3 The present invention relates to drilling tools as are
4 typically used for drilling well bores.

5

6 Conventionally, when drilling a well bore of the type used
7 in oil or gas production, a string of drill pipe having a
8 drill bit on the lower end thereof is advanced into the
9 ground. As the drill is advanced into the ground it
10 encounters different rock formations, some of which may be
11 unstable. To minimise problems which may be incurred by
12 running the drill bit from one formation to another, it is
13 common practice to run the drill bit to a predetermined
14 depth, and then remove or "trip" the drill string from the
15 bore. Structural casing, typically made of heavy steel
16 piping, is then lowered into the bore and cemented in place
17 when set. The casing acts as a lining within the bore, and
18 prevents collapse of the newly drilled bore or
19 contamination of the oil or gas reservoir.

20

21 As a consequence of having to carry out the above
22 procedure, the cost and time taken to drill a bore is

1 increased as it is necessary to perform a number of trips
2 down the well. It will be appreciated that at the
3 considerable depths reached during oil and gas production
4 the time taken to implement complex retrieval procedures to
5 recover the drill string can be very long, and accordingly
6 the beginning of profitable production can be greatly
7 delayed.

8
9 An attempt has been made to mitigate this problem with the
10 introduction of a procedure known as "drilling with
11 casing". This procedure relies on the attachment of a
12 drill bit to the actual casing string, so that the drill
13 bit functions not only to drill the earth formation, but
14 also to guide the casing into the well bore. This is
15 advantageous as the casing is pulled into the bore by the
16 drill bit, and therefore negates the requirement of having
17 to retrieve the drill string and drill bit after reaching a
18 target depth to allow cementing.

19
20 While this procedure greatly increases the efficiency of
21 the drilling procedure, a further problem is encountered
22 when the casing is cemented upon reaching the desired
23 depth. The advantage of drilling with casing is that the
24 drill bit does not have to be retrieved from the well bore.
25 However as a result, should drilling to a greater depth be
26 required after cementing the casing, the subsequent drill
27 bit has to pass through the previous bit in order to
28 advance. This is extremely difficult as drill bits are
29 required to remove hard rock material and are accordingly
30 very resistant and robust structures typically manufactured
31 from materials such as Tungsten Carbide or steel.
32 Attempting to drill through an old drill bit may result in

1 damaging the new drill bit, adversely affecting the
2 efficiency of any further drilling. Consequently, the
3 damaged drill bit would have to be retrieved from the bore
4 and replaced, and the time and cost advantage gained by
5 using the drilling with casing procedure would be lost.

6
7 It would therefore be a distinct advantage to provide a
8 drill bit for use during drilling with casing which can
9 drill rock and earth formations but which can also be
10 drilled through by another drill bit. The provision of a
11 drill bit which allows the passage of a subsequent drill
12 bit through it, would reduce the number of trips into a
13 well bore required during a normal drilling procedure and
14 minimise the risk of damaging any further drill bits
15 introduced into the bore.

16

17 In our prior Patent Application PCT/GB99/01816 we have
18 suggested that the drill bit has hard drilling material
19 that may be moved away from the remaining body of the drill
20 shoe prior to subsequent drilling through of the drill bit.
21 We have also proposed EP0815342, a drill bit or shoe having
22 hard drilling material placed only on the drill shoe or bit
23 at the peripheral circumference thereof, and specifically
24 only at the sides of the drill bit or shoe where the
25 diameter is greater than the internal diameter of the
26 casing. The present invention is distinguished from both of
27 these teachings in that it provides for a drill shoe or bit
28 that has hard material within the area below the internal
29 boundaries of the casing, and does not require moving parts
30 to be displaced before subsequent drilling through can be
31 commenced.

32

1

2 It is an object of the present invention to provide a drill
3 bit for use in a well bore which can drill earth and rock
4 formations and guide a casing string into a well bore
5 simultaneously.

6

7 It is a further object of the present invention to provide
8 a drill bit for use in a well bore which is constructed
9 from a material which allows a second drill bit to drill
10 through it.

11

12 It is a yet further object of the present invention to
13 provide a drill bit for use in a well bore which allows a
14 second drill bit to drill through it, such that the second
15 drill bit is not damaged and can progress beyond the point
16 reached by the original drill bit within the well bore.

17

18 According to a first aspect of the present invention there
19 is provided a drill bit for drilling with casing in a well
20 bore, said drill bit being constructed from a combination
21 of a relatively soft material and a relatively hard
22 material, wherein the hard material is suitable for cutting
23 earth or rock, and wherein the combination of materials is
24 in such proportion and in such arrangement to allow a
25 subsequent further drill bit to drill through it.

26

27 Preferably the drill bit is substantially constructed from
28 the relatively soft material, wherein the relatively soft
29 material is adapted to be drilled through with a standard
30 earth drill bit.

31

1 Preferably the drill bit is formed with a body having or
2 being associated with a nose portion upon which are cutting
3 members, wherein the body is made substantially from the
4 relatively soft material and at least the leading edge or
5 cutting surface of each cutting member is made from the
6 hard material.

7
8 Preferably the hard wearing material is a hard material
9 such as tungsten carbide or a superhard material such as
10 diamond composite or cubic boron nitride although any other
11 suitable material may be used.

12
13 Preferably the soft, drillable material is aluminium.
14 Alternatively the soft drillable material is copper or
15 brass alloy, although any other suitable material could be
16 used.

17
18 There may be a plurality of soft materials and there may be
19 a plurality of hard materials.

20
21 In one possible embodiment the nose is directly coated with
22 the hard wearing material.

23
24 Optionally the coating is a continuous layer or film that
25 covers the surface of the nose.

26
27 Alternatively the coating is non-continuous, such that the
28 nose is afforded areas which are not coated by the hard
29 wearing material, wherein upon rotation of the drill bit
30 the cumulative effect of the coated areas gives complete
31 circumferential coverage of the dimensions of the drilled
32 hole.

1

2 Alternatively the coating may be applied to an intermediate
3 which is amenable to the nose of the drill bit.

4

5 Preferably the intermediate is nickel.

6

7 The intermediate may be attached to the nose prior to
8 coating with the hard wearing material. Optionally the
9 intermediate may be coated with the hard wearing material
10 prior to attachment to the nose.

11

12 In a second embodiment the hard wearing material is applied
13 to the nose in the form of preformed elements wherein the
14 cumulative effect of said preformed elements is to cover
15 the surface of the nose and so act as a coating thereof.

16

17 The preformed elements may be chips or fragments of the
18 hard material.

19

20 The preformed elements of the hard material may be directly
21 applied to the nose.

22

23 Alternatively the preformed elements of hard material are
24 applied to the nose following the application of an
25 amenable intermediate material to the nose or the preformed
26 elements.

27

28 Preferably the amenable intermediate material is nickel
29 substrate.

30

1 The preformed elements may be attached to the nose by
2 standard techniques such as brazing, welding or shrink
3 fitting.

4
5 Optionally the preformed elements have a re-enforced
6 structure to aid drilling of hard formations. Where the
7 preformed elements have a re-enforced structure, preferably
8 the preformed elements are pre-weakened prior to attachment
9 to the nose in order to allow fracture of the preformed
10 elements upon drilling.

11
12 Preferably the drill bit may also comprise a plurality of
13 flow ports to allow fluid bypass and lubrication of the
14 bit.

15
16 Preferably the drill bit also comprises a stabiliser or
17 centraliser.

18
19 Preferably the drill bit also comprises reaming members.

20
21 According to a third aspect of the present invention there
22 is provided a method of fixing a hard or super hard wearing
23 material to a drill bit nose made of a soft drillable
24 material, wherein a jet is used to blow gases at very high
25 speeds towards a cast of the nose and particles of the hard
26 or superhard wearing material are introduced into the gas
27 stream, wherein the kinetic energy of the procedure is
28 converted to thermal energy which welds the particles to
29 the nose.

30
31 According to a fourth aspect of the present invention there
32 is provided a method for fixing a hard or superhard wearing

1 material to a drill bit nose made of a soft drillable
2 material, wherein particles of the hard or superhard
3 wearing material are placed within a mould and thereafter
4 the soft drillable material is poured in molten form into
5 the mould, such that on cooling said hard or superhard
6 wearing particles are set in situ.

7
8 Alternatively the hard wearing material can be fixed to the
9 nose by a standard technique such as brazing, welding and
10 electroplating.

11
12 In order to provide a better understanding of the
13 invention, example embodiments of the invention will now be
14 illustrated with reference to the following Figures in
15 which;

16
17 Figure 1 illustrates a drill bit in accordance with the
18 present invention;

19
20 Figure 2 is an elevated view of the top of the drill bit;

21
22 Figure 3 illustrates an individual cutting member isolated
23 from the drill bit.

24
25 Figure 4 illustrates an elevated view of the top of an
26 alternative embodiment of a drill bit in accordance with
27 the present invention; and

28
29 Figure 5 illustrates a pre-formed element for attaching to
30 the nose portion of a drill bit.

31

1 Referring firstly to Figure 1, a drill bit generally
2 depicted at 1, is comprised of a cylindrical body 2, that
3 can be mounted on the lower end of a casing string (not
4 shown) via a thread end connection 3 that can mate with the
5 casing. The drill bit 1 is further comprised of a
6 plurality of cutting members 4 which are fixed to the
7 opposite end of the body 2 to the thread end connection 3,
8 namely the nose end 5. The cutting members 4 extend out
9 from the nose end 5.

10

11 The nose 5 and cutting members 4 are constructed from a
12 material such as aluminium, copper or brass alloy which is
13 soft enough to allow the aforementioned nose 5 and members
14 4 to be drilled through by a second and subsequent drill
15 bit (not shown). The cutting members 4 are substantially
16 covered by a relatively hard material 6 typically being a
17 hard material such as tungsten carbide or a superhard
18 material such as diamond composite or cubic boron nitride.
19 In the depicted embodiment the relatively hard material 6
20 is located at the "leading edge" of the cutting member 4.
21 In this respect the "leading edge" refers to the side of
22 the cutting member 4 which directly contacts the ground or
23 rock upon rotation of the drill bit 1. It is recognised
24 that whilst in the depicted embodiments the hard wearing
25 material is afforded to the leading edge of one or more
26 cutting members 4 on the drill bit 1, the invention is not
27 limited to this configuration. For example the hard
28 wearing material may be applied to the nose 5 in an
29 embodiment having no cutting members 4 or may be applied to
30 the whole surface of the cutting members 4.

31

1 The relatively hard material 6 may be applied to the
2 cutting members 4 or nose 5 as a coating, that is as a
3 layer or film. In one embodiment a continuous layer of the
4 material 6 may cover the entire surface of the nose 5, or
5 the cutting members 4. Alternatively a non-continuous
6 layer of the material may coat the nose 5 or cutting
7 members 4. In this instance, the surface of the nose 5 or
8 cutting members 4 will comprise areas that are not coated.
9 However, upon rotation of the drill bit 1, the cumulative
10 effect of the coated areas will be complete circumferential
11 coverage of the inside diameter of the casing in which the
12 drill bit is located.

13

14 It is recognised in the present invention that direct
15 application of some coatings to the nose material may not
16 be practical. For example, extremely hard tungsten carbide
17 particles cannot be applied to the preferred nose materials
18 (e.g. aluminium or copper) by lasercarb welding. This
19 material can be applied to soft nickel, however machining
20 said drill bit 1 entirely from nickel would be unduly
21 expensive. Therefore in an alternative embodiment, a
22 coating of the hard material 6 is applied to an
23 intermediate, typically being nickel substrate, which is
24 then attached to the nose 5 of the drill bit 1.
25 Alternatively the nickel substrate can be attached to the
26 nose 5 prior to coating.

27

28 In a further embodiment preformed elements of the hard or
29 superhard material 6 are applied to the nose 5 or cutting
30 members 4 of the drill bit 1 in place of a coating of film.
31 Said preformed elements may be chips, or fragments of the
32 hard material 6. Typically the cumulative effect of the

1 preformed elements is to cover the surface of the nose 5 or
2 the cutting members 4 and so act as a coating thereof. The
3 preformed elements may be directly applied to the nose 5 or
4 cutting members 4 or may be applied after applying an
5 amenable material either to the nose 5 or cutting members 4
6 or the preformed element itself. The amenable material is
7 typically nickel substrate.

8
9 The layout of cutting members 4 can be seen more clearly in
10 Figure 2 which shows the nose end 5, viewed from above, and
11 in Figure 3 which shows an individual cutting member 4. It
12 can be seen in Figure 3 that the cutting means 6 has teeth
13 formations 10 which allow any "chips" of material remaining
14 in the well bore to pass through the blade structure.

15
16 The nose 5 further comprises flow by areas 7 that allow
17 fluid circulated within the well bore to lubricate the
18 surfaces of the bit 1. The body 2 also comprises a
19 stabiliser or centraliser 9 which maintains the drill bit
20 in the centre of the well bore, and reaming members 8,
21 which function to remove any irregularities or obstructions
22 from the wall of the bore.

23
24 In use, the drill bit 1, is run into a well bore (not
25 shown) from the surface, typically whilst being rotated.
26 The drill bit 1 pulls a casing string (not shown) as it is
27 advanced into the newly formed well bore to a predetermined
28 depth. Upon reaching this depth, the casing is cemented to
29 strengthen the lining of the bore. If drilling beyond this
30 first assembly is required, a second drill bit of a smaller
31 diameter to the first is run into the well inside the
32 casing string from the surface.

1
2 Upon reaching the first assembly, the new drill bit can
3 drill through the soft drillable material of the original
4 drill bit 1 and cutting members 4, and therefore can
5 proceed to a point beyond the depth reached by the original
6 drill bit 1 within the well bore. The hard or super hard
7 material 6 fixed to the cutting members 4 of the original
8 drill bit 1 disintegrate into shavings when drilled. The
9 shavings released into the well bore when the original bit
10 1 is drilled through do not obstruct the bore and are
11 therefore not detrimental to the subsequent drilling
12 process. In this manner a further section of the bore can
13 be drilled beyond the previously attained depth without
14 damage to the new drill bit and without needing to retrieve
15 the first assembly from the bore.

16
17 When used for drilling through harder formations a thicker
18 section of the preformed element will be required. However
19 it will be appreciated that in such an instance, said
20 preformed elements would not be drillable. Thereby in the
21 event that a thicker element is required, said element is
22 typically pre-weakened prior to attachment to the nose 5 or
23 cutting members 4. In this manner, the elements will have
24 the attributes of high stiffness whilst drilling but low
25 resistance to fracture whilst being drilled. The pre-
26 formed elements can then be applied directly to the nose 5
27 or cutting members 4 by brazing or shrink-fitting or could
28 be attached to an amenable material, typically nickel
29 substrate.

30
31 A first method for fixing the hard or superhard material 6
32 is now outlined. A jet is used to blow gases at very high

1 speeds towards a cast or block of the cutting member 4 or
2 nose 5, and which is made from the soft, drillable
3 material. Typically a speed in the region of Mach 2 is
4 used. Very fine particles of the hard or superhard wearing
5 material are introduced into the gas stream. The resulting
6 kinetic energy is converted to thermal energy in the
7 particles, and accordingly the heated particles "weld" to
8 the leading edge of the cast or block therefore forming a
9 thin layer or film.

10

11 It will be appreciated that the abovedescribed method could
12 be used with particles of the hard or superhard material,
13 or with intermediates coated by the hard or super hard
14 material or with preformed elements as described above.

15

16 An alternative method for fixing preformed hard or
17 superhard particles to the cutting members 4 is to place
18 them within a drill mould. Molten drillable soft material
19 that will eventually become the nose 5 of the drill bit 1
20 is then poured into the mould. On cooling the metal
21 provides a drill bit 1 that has the hard or superhard
22 particles set in situ.

23

24 The present invention is inherent with significant
25 advantages in that the time taken for the drilling
26 operation can be greatly reduced as there is no need to
27 implement complex and timely retrieval operations to
28 recover apparatus from the bore. As a result the
29 profitable stage of production can be begin much sooner.

30

31 A further advantage, is that unlike the drill bits known to
32 the art, the drill bit of the present invention is

1 drillable by another drill bit and the risk of damage to
2 the second drill bit is therefore reduced. Furthermore as
3 the cutting means of the cutting members consist of fine
4 layers or cutting elements formed from hard material, they
5 disintegrate into shavings upon drilling and therefore do
6 not act as an obstruction to any subsequent apparatus that
7 is advanced into the well.

8

9 Further modifications and improvements may be incorporated
10 without departing from the scope of the invention herein
11 intended.

1 Claims:

2

3 1. A drill bit for drilling with casing in a well bore,
4 said drill bit being constructed from a combination of
5 a relatively soft material and a relatively hard
6 material, wherein the hard material is suitable for
7 cutting earth or rock, and wherein the combination of
8 materials is in such proportion and in such
9 arrangement to allow a subsequent further drill bit to
10 drill through said drill bit.

11

12 2. A drill bit as claimed in Claim 1 substantially
13 constructed from the relatively soft material, wherein
14 the relatively soft material is adapted to be drilled
15 through with a standard earth drill bit.

16

17 3. A drill bit as claimed in Claim 1 or Claim 2 formed
18 with a body having or being associated with a nose
19 portion upon which are cutting members, wherein the
20 body is made substantially from the relatively soft
21 material and at least a leading edge or cutting
22 surface of each cutting member is made from the
23 relatively hard material.

24

25 4. A drill bit as claimed in any one of the preceding
26 Claims, wherein the hard material is tungsten carbide.

27

28 5. A drill bit as claimed in any one of Claims 1 to 3,
29 wherein the hard material is diamond composite.

30

31 6. A drill bit as claimed in any one of Claims 1 to 3,
32 wherein the hard material is cubic boron nitride.

- 1
- 2 7. A drill bit as claimed in any one of the preceding
- 3 Claims wherein the soft material is aluminium.
- 4
- 5 8. A drill bit as claimed in any one of Claims 1 to 6,
- 6 wherein the soft material is copper or brass alloy.
- 7
- 8 9. A drill bit as claimed in any one of the preceding
- 9 Claims having a plurality of soft materials.
- 10
- 11 10. A drill bit as claimed in any one of the preceding
- 12 Claims having a plurality of hard materials.
- 13
- 14 11. A drill bit as claimed in any one of the preceding
- 15 Claims wherein the hard material is provided as a
- 16 coating.
- 17
- 18 12. A drill bit as claimed in Claim 11 wherein the coating
- 19 is applied to the nose portion.
- 20
- 21 13. A drill bit as claimed in Claim 11 or Claim 12 wherein
- 22 the coating is a continuous layer or film.
- 23
- 24 14. A drill bit as claimed in Claim 11 or Claim 12 wherein
- 25 the coating is non-continuous, such that surfaces of
- 26 the drill bit are afforded areas which are not coated
- 27 by the hard material, wherein upon rotation of the
- 28 drill bit, the cumulative effect of the coated areas
- 29 gives complete circumferential coverage of the
- 30 dimensions of the drilled well bore.
- 31

- 1 15. A drill bit as claimed in any one of the preceding
2 Claims wherein the hard material is applied to an
3 intermediate which is amenable to the nose of the
4 drill bit.
5
- 6 16. A drill bit as claimed in Claim 15 wherein the
7 intermediate is nickel.
8
- 9 17. A drill bit as claimed in any one of Claims 1 to 10
10 wherein the hard wearing material is applied to the
11 nose as preformed elements wherein the cumulative
12 effect of said preformed elements is to cover the
13 surface of the nose and so act as a coating thereof.
14
- 15 18. A drill bit as claimed in Claim 17 wherein the
16 preformed elements are chips or fragments of the hard
17 material.
18
- 19 19. A drill bit as claimed in Claim 17 or 18 wherein the
20 preformed elements are attached to the nose by
21 brazing.
22
- 23 20. A drill bit as claimed in any one of Claims 17 to 19
24 wherein the preformed elements have a reinforced
25 structure to aid drilling of hard formations.
26
- 27 21. A drill bit as claimed in Claim 20 wherein the
28 preformed elements are pre-weakened prior to
29 attachment to the nose in order to allow fracture of
30 the preformed elements upon drilling.

- 1 22. A drill bit as claimed in any one of the preceding
2 Claims also comprising a plurality of flow ports to
3 allow fluid bypass and lubrication of the bit.
4
- 5 23. A drill bit as claimed in any one of the preceding
6 Claims also comprising a stabiliser or centraliser.
7
- 8 24. A drill bit as claimed in any one of the preceding
9 Claims also comprising reaming members.
10
- 11 25. A method of fixing a hard or super hard wearing
12 material to a drill bit nose made of a soft drillable
13 material, wherein a jet is used to blow gases at very
14 high speeds towards a cast of the nose and particles
15 of the hard or superhard wearing material are
16 introduced into the gas stream, wherein the kinetic
17 energy of the procedure is converted to thermal energy
18 which welds the particles to the nose.
19
- 20 26. A method for fixing a hard or superhard wearing
21 material to a drill bit nose made of a soft drillable
22 material, wherein particles of the hard or superhard
23 wearing material are placed within a mould and
24 thereafter the soft drillable material is poured in
25 molten form into the mould, such that on cooling said
26 hard or superhard wearing particles are set in situ.
27
- 28 27. A method for drilling a well bore comprising attaching
29 a drill bit in accordance with any one of the
30 preceding Claims to casing, drilling a bore through
31 the earth formation and subsequently running a further

- 1 drill bit in the well inside the casing and drilling
- 2 through the first drill bit.
- 3

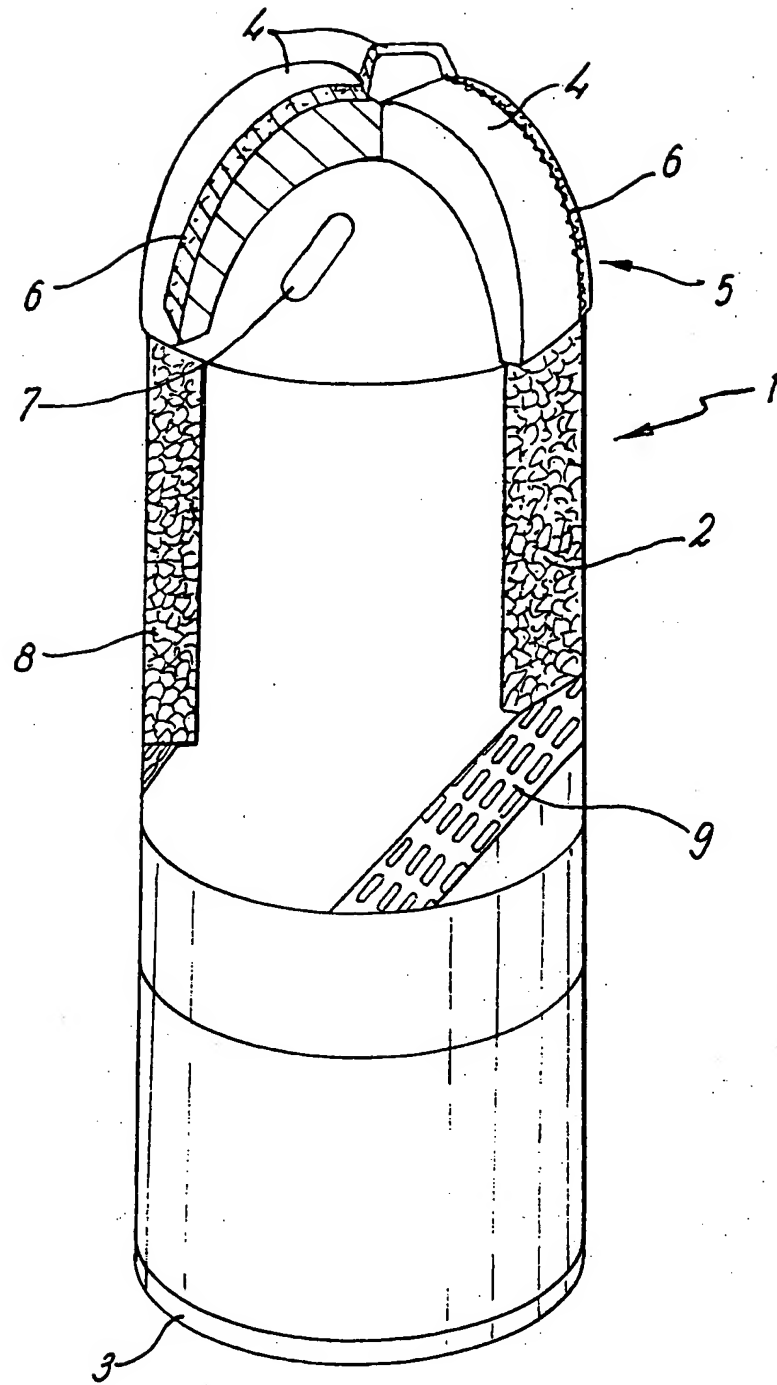


Fig. 1

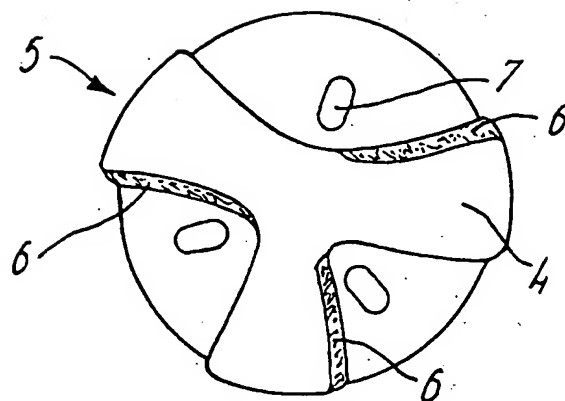


Fig. 2

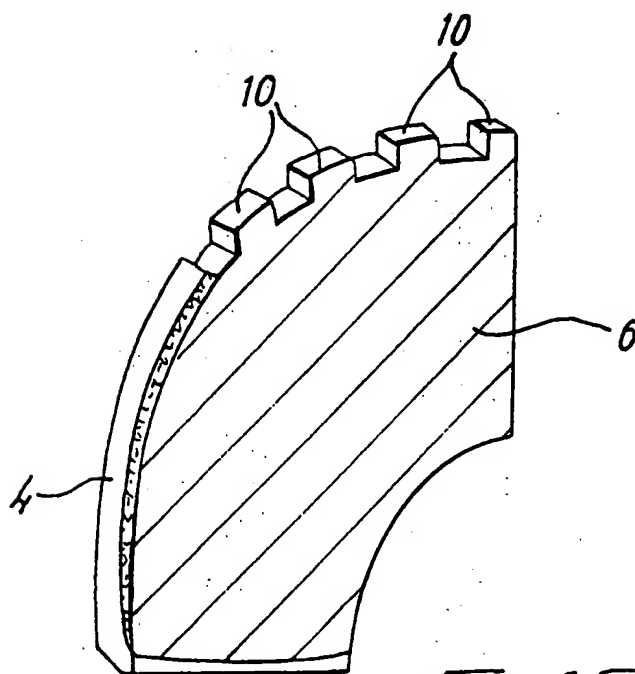


Fig. 3

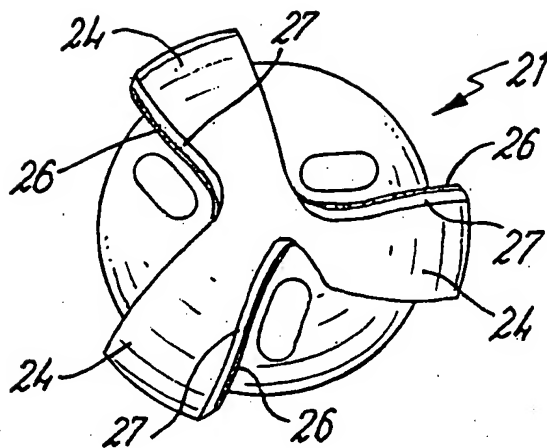


FIG. 4

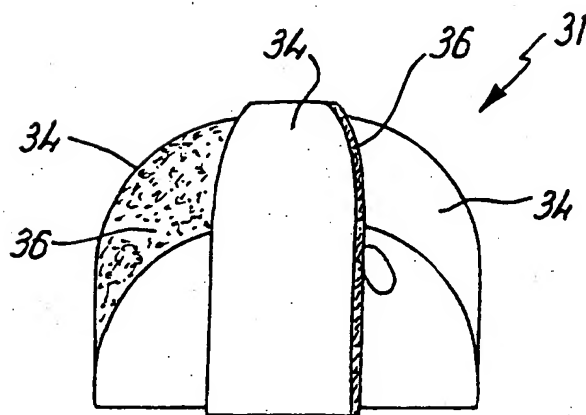


FIG. 5

INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 00/04936

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 E21B7/20 E21B10/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 957 225 A (SINOR LAWRENCE ALLEN) 28 September 1999 (1999-09-28)	1,3,5,9, 22,27
Y	column 5, line 15 - line 20 column 6, line 5 - line 12 column 13, line 37 - line 40 column 13, line 57 - line 60; figures 6A,6B,7	4,6-8, 11-19, 23-26
Y	US 5 096 465 A (CHEN SY-HWA ET AL) 17 March 1992 (1992-03-17) column 1, line 27 - line 30 column 10, line 44 - line 49 -/--	4,6

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Date of the actual completion of the international search

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